Magnetic Resonance Imaging for Prenatal Diagnosis: An Adjunct Diagnostic Tool

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Purpose. To investigate the value of magnetic resonance imaging (MRI) for prenatal diagnosis.
Methods. Seven cases with structural anomalies initially diagnosed by prenatal ultrasound and MRI were collected from 1 January 2004 to 31 December 2005.
Results. Central nervous system anomalies were diagnosed in six fetuses and sacrococcygeal teratoma was diagnosed in one fetus by prenatal ultrasound. All of the results from magnetic resonance imaging were similar to prenatal ultrasound diagnosis but MRI provided more information, including the exact anatomical location of the diseased site, especially in the fetuses with central nervous system anomalies.
Conclusion. Magnetic resonance imaging is a valuable adjunct diagnostic modality for prenatal diagnosis of fetal anomalies. It provides supplementary clinical information about both prenatal and postnatal pathological anatomic structures. **(Mid Taiwan J Med 2007;12:198-202)**

Key words

magnetic resonance imaging, prenatal diagnosis

INTRODUCTION

Prenatal ultrasound is commonly used for early diagnosis of fetal anomalies. Ultrasound provides critical information needed for prenatal screening, but additional diagnostic imaging tools may be necessary for fetal assessment. Ultrasonography is favored for fetal assessment because it is a non-ionizing radiation modality and provides real time imaging. However, unfavorable fetal position, maternal habitus and oligohydramnion can limit the ultrasound evaluation.

Magnetic resonance imaging has been used for prenatal diagnosis since the early 1980s. In the beginning, frequent fetal movements during the examination limited its use and the interpretation of the images. The development of fast and ultra-fast magnetic resonance imaging has decreased or eliminated the amount of motion artifacts produced by moving fetuses [1]. The scanning time has decreased to less than one and a half seconds. Fourier single-shot turbo spin-echo (HASTE) has proven to be an excellent modalty for human fetal imaging [1]. Furthermore, there is no evidence of adverse biological effects when an electromagnetic field strength of 1.5 T or less is used. MRI can be used in pregnant women if prenatal ultrasound does not provide sufficient information for prenatal diagnosis.

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MATERIALS AND METHODS

We reviewed the patient charts and examination results of seven fetuses that had undergone ultrasound and magnetic resonance imaging from 1 January 2004 to 31 December 2005. In all of the fetuses, targeted ultrasound was done in our hospital by a specialist in fetal maternal medicine. The magnetic resonance imaging of the fetuses was performed using the same imaging machine (Single-Shot Fast-Spin Echo). The images were interpreted by a well-trained radiologist. The MR imaging results were compared with the prenatal ultrasound results.

Continuation or termination of pregnancy was dependent on the severity of fetal anomalies.

RESULTS

Fetal anomalies involving the central nervous and skeletal systems were initially found by prenatal ultrasound. The majority of the fetuses had nervous system abnormalities. All of the prenatal ultrasound findings were compared with the findings from prenatal or postnatal magnetic resonance imaging. The descriptions of the seven fetuses are summarized in the Table.

Prenatal ultrasound precisely diagnosed the structural anomalies but prenatal magnetic resonance imaging provided the exact location and the extent of disease.

Arachnoid cyst was diagnosed in fetus 1 and fetus 2 by prenatal ultrasound (Table, Fig. 1). Prenatal magnetic resonance imaging revealed the exact anatomical sites and extent of severity. Postnatal and prenatal magnetic resonance images were compatible. Both of the fetuses were delivered at term and required neonatal shunts.

In fetus 3, microcephaly and ventriculomegaly were diagnosed by prenatal ultrasound; however, prenatal magnetic resonance imaging revealed severe frontal lobe hypoplasia of the brain. The possibility of neonatal brain sequelae was considered and the parents were informed of the prognosis. In fetus 4, sacroccygeal teratoma with intra-pelvic mass was antenatally diagnosed. Magnetic resonance imaging showed the extent of tumor location, tumor size and the anatomical association with vital organs (Fig. 2). In this case, termination of pregnancy was suggested at 22 weeks' gestational age because the extent of disease was severe.

Ventriculomegaly was initially diagnosed by prenatal ultrasound in fetuses 5 and 6. Prenatal magnetic resonance imaging confirmed the diagnosis of colpocephaly in both of the patients. The mother with fetus 5 continued pregnancy and the baby was delivered in our hospital. However, neonatal information was not retrieved for fetus 6 because the patient did not receive further management at our hospital. Leukomalacia was detected on magnetic resonance imaging in fetus 7 while prenatal ultrasound only showed hydrocephalus. The fetus was delivered and a ventricular-peritoneal shunt was inserted.

DISCUSSION

Congenital abnormalities account for 20% to 25% of perinatal deaths. Various kinds of prenatal diagnostic modalities are used to predict fetal disorders and genetic disease, and to determine the health of the unborn fetus. Ultrasound is the most commonly used noninvasive diagnostic screening tool for imaging fetal anatomy. It is harmless to both the fetus and the mother. Ultrasound can evaluate gestational age, amniotic fluid volume, fetal position, placental location, fetal growth and structural birth defects, and identify multiple pregnancies. However, maternal habitus, gestational age, oligohydramnios and fetal malpresentation limit

Table. Comparison between prenatal ultrasound, prenatal and postnatal MRI

Case	Prenatal ultrasound	Prenatal MRI	Postnatal MRI	Management and Outcome
1	Arachnoid cyst	Supratentorial Arachnoid cyst	Compatible	Neonatal C-P shunt
2	Arachnoid cyst	Interhemispheric Arachnoid cyst	Compatible	Neonatal C-P shunt
3	Microcephaly Ventriculomegaly	Ventriculomegaly Frontal lobe hypoplasia	NA	Lost to follow up
4	Sacroccygeal teratoma	Sacroccygeal teratoma	NA	Termination of pregnancy
5	Ventriculomegaly	Agenesis of corpus callosum with colpocephaly	Compatible	Continued pregnancy
6	Ventriculomegaly	Unilateral colpocephaly	NA	Lost to follow-up
7	Hydrocephalus	NA	Hydrocephalus Leukomalacia	Neonatal V-P shunt

NA = postnatal MRI not performed; C-P shunt = cyst-peritoneal shunt; V-P shunt = ventriculo-peritoneal shunt.

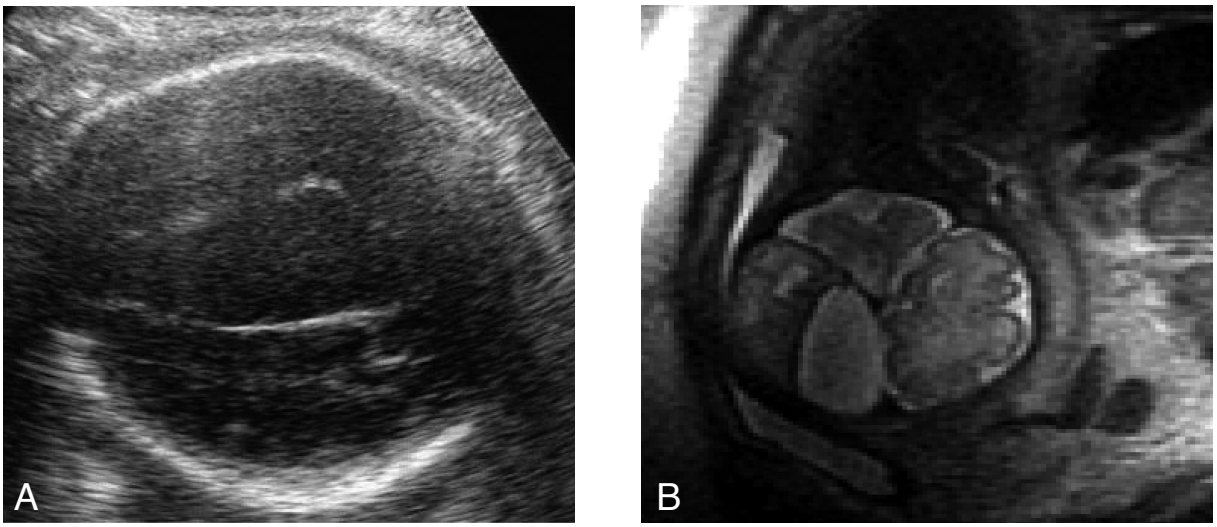

Fig. 1. A: Ultrasound showing supratentorial arachnoid cyst. B: MRI precisely locates the cyst and its involvment with peripheral brain structures.

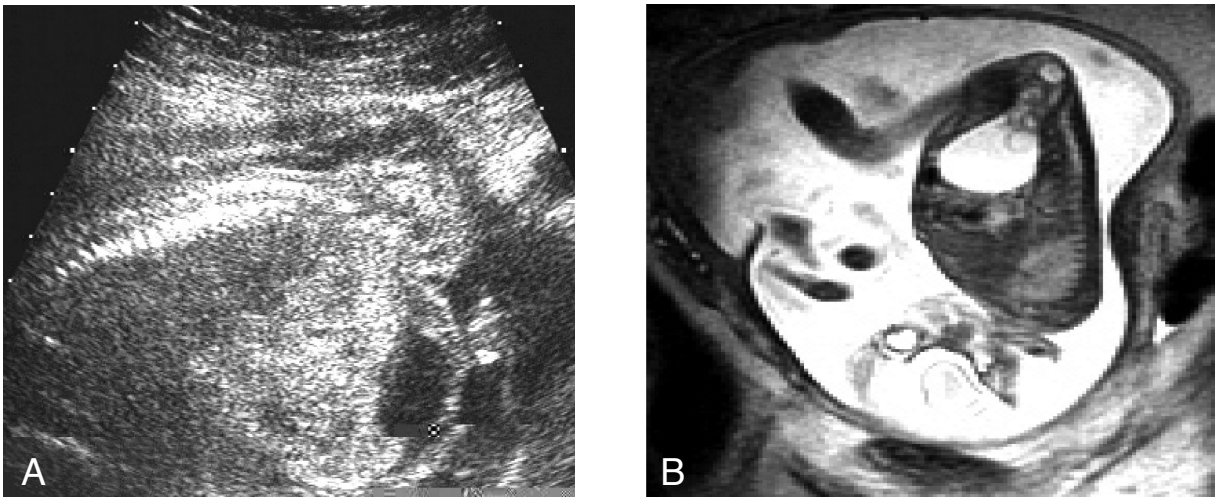

Fig. 2. A: Ultrasound revealing sacroccygeal teratoma. B: MRI shows the tumor involvement and the components of the tumor.

the diagnosis of structural anomalies. MRI can solve the limitations found in prenatal ultrasound. Prospective studies have revealed some advantages of prenatal magnetic resonance imaging [2].

Magnetic resonance imaging provides detailed and reproducible diagnosis of fetal structural anomalies. MRI is most useful in evaluation of abnormalities of the fetal brain, neck, chest, and abdomen.

Evaluation of anomalies in the fetal brain and spine with ultrasound is limited. MRI has been shown to augment ultrasound diagnosis of CNS abnormalities. The normal and abnormal appearance of the brain on ultrasound is based on the ability to obtain specific images of the cerebrum, cerebellum, and spine.

Ventriculomegaly is the most common abnormal structure found during the antenatal ultrasound in fetal brain scanning. Mild to moderate enlargement of the ventricles is frequently associated with other anomalies [3]. Compared with ultrasound, MRI more accurately shows the cause of ventriculomegaly and identifies associated brain anomalies. Abnormalities of the corpus callosum, such as partial agenesis may be difficult to diagnose on ultrasound. MRI can differentiate between partial

agenesis and thinning of the corpus callosum. Other abnormalities including arachnoid cyst and holoprosencephaly can be easily diagnosed by prenatal ultrasound, although MRI can provide additional information, such as anatomical location.

Sacrococcygeal tumors are usually diagnosed prenatally by ultrasound and are classified according to the amount of extra-or intra-pelvic components. Degree of increased vascularity detected on the tumors by ultrasonography is related to the severity of the disease and inversely to postnatal outcome. However, MRI better defines intra-spinal and intra-pelvic extension of the tumor. MRI differentiates tumors that are predominantly cystic from sacral myelomeningocele tumors [4].

Prenatal magnetic resonance imaging also provides further information regarding lesions of the fetal neck, thorax and abdomen. MRI can help define the relationship between the lesion and the airway, major neck vessels, the degree of liver herniation into the chest in diaphragmatic hernia, and assess the intra-abdominal location and degree of tumor involvement. However, MRI does not provide sufficient information for fetal renal anomalies.

Magnetic resonance imaging provides additional information and aides in further obstetric counseling and management. It provides vital information that can be utilized for better antepartum management. Prenatal diagnosis also allows the obstetrician and neonatologist to be adequately prepared for a potentially ill neonate at delivery. It is unlikely that MRI will replace ultrasound as the primary obstetric imaging modality in the near future, but MRI is helpful in evaluating gross fetal anomalies and disturbances of fetal growth and development when ultrasound is limited by oligohydramnios, fetal position or maternal obesity.

In this article, we described our experience in assessing fetal abnormalities based on MRI. Indications for MRI during pregnancy are limited but well defined. It is generally useful as an additional tool for further evaluation of problems that are initially detected by ultrasound. Improved prenatal diagnosis by magnetic resonance imaging can lead to changes in perinatal management, including the timing of delivery, reduction in parental anxiety, and contribute more data to aid in obstetric counseling and postnatal care.

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核磁共振影像應用於產前診斷：輔助工具

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目的　運用核磁共振影像作爲產前診斷胎兒異常的輔助工具。

方法　從2004年1月1日至2005年12月31日之間的回顧性研究。 總共有七個產前超音波異常之胎兒，安排核磁共振影像作爲進一步的診斷工具，並提供更多資訊來協助診斷及治療。

結果　總共有七個病例，其中包含六個中樞神經系統異常的病例，另有一個病例爲sacrococcygeal teratoma，都由產前超音波診斷。所有結果與產前超音波診斷完全相符，但核磁共振影像提供更多訊息，尤其爲中樞神經系統異常時能呈現較完整的解剖圖像。

結論　核磁共振影像似乎可作爲選擇性產前診斷輔助工具。它可以提供產前，產後胎兒之病變部位的結構及更多的臨床資訊。（**中台灣醫誌2007;12:198-202**）

關鍵詞

核磁共振影像，產前診斷

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